# An integrated model system tool to evaluate the impact of urban mobility policies on air pollution: Barcelona case study

Daniel Rodriguez-Rey*, Marc Guevara*, Josep Casanovas*†
*Barcelona Supercomputing Center, Barcelona, Spain
†Universitat Politècnica de Catalunya, Barcelona, Spain
E-mail: {daniel.rodriguez, marc.guevara}@bsc.es

***Abstract*—Air pollution remains as a key unresolved problem in many urban areas. Cities with such problem are gradually implementing Traffic Management Strategies (TMS) to reduce the total kilometers travelled by vehicles and subsequently decrease emissions. However, a prior evaluation of such TMS is needed if the target goals want to be achieved. In this sense, the combination of traffic simulation with emissions and air quality models can be of great use to assess the potential impacts of such policies. This study presents an integrated modelling system tool for Barcelona that allows to estimate the changes induced by the implementation of TMS on traffic activity, emissions and air quality levels at a very spatial (street level) and temporal (hourly level) resolution.**

***Keywords*—Traffic emissions, Traffic modelling, traffic management strategies.**

## I. Extended Abstract

### A. Introduction

In the city of Barcelona (Spain), chronic nitrogen dioxides ($NO_2$) and fine particular matter ($PM_2.5$) concentrations exceeding the 2008/50/EC EU Ambient Air Quality Directive (AQD) and the World Health Organization (WHO) air quality guidelines (AQGs) are being recorded in urban traffic stations [1]. Several studies have also highlighted the impacts of air pollution on public health [2]. Local authorities are focusing on mobility policies (e.g. implementation of Low Emission Zones, traffic calming) that try to reduce the number of circulating vehicles within the city. In this sense, the application of numerical models is highlighted in the AQD as a fundamental tool to better assess and manage air quality, encouraging their use in the evaluation of air quality plans. In order to simulate the effect of restrictions on the traffic activity across a city, an integrated and dynamical system that links a transportation model with an emissions model and an air quality model is needed.

### B. Related work and research contribution

During the last years, several works have performed the assessment of the effect of TMS in air pollution by coupling traffic models with air quality systems. Most of these studies have used mesoscale air quality systems, which are limited to spatial resolutions of $1km^2$ and therefore cannot depict the strong urban pollutant concentration gradients. Works evaluating the impact of TMS at street-level have been limited to restricted domains (e.g. [3]). The system presented in this work allows to estimate street-level emission values in Barcelona by a dynamic approach able to estimate the effect of different TMS. The complete workflow is detailed on section I-C.

### C. Methods

The integrated modeling system is based on: (i) a detailed multimodal transport model of Barcelona (VML) in VISUM [4] and (ii) the HERMESv3 emission model, which computes street-level and hourly road traffic emissions [5]. The simulation domain of the system comprises the Primary Crown of Barcelona, including Barcelona and other municipalities from the metropolitan area (95 $km^2$). The dynamical information on traffic flow and travelling speed modelled at the road link level by VML is passed to HERMESv3, which combines the aforementioned information with the emission factors reported by COPERT V [6]. In the present work, a business as usual (BAS) and a traffic restriction scenario (TR) are simulated to illustrate the capabilities of the system. The traffic restriction scenario represents the superblocks policy which is gradually being applied all over Barcelona. This consists on the traffic calming of certain streets within an area comprised by several blocks. Mobility demand was supposed to be constant during the introduction of superblocks, which means that the same amount of vehicles is loaded into the network. Under the restrictions applied, new vehicle routes will be generated through the non-restricted streets.

### D. Results

Total NOx 2016 annual emissions for the BAS scenario are represented in figure 1a. The total annual $NO_x$ road transport emissions were compared against the latest available local emission inventory done by Barcelona Regional (BR) ([7]) corresponding to the year 2017. Estimated NOx emissions by the integrated model are a 9% higher than the estimated by BR. This difference is a consequence of the (i) different years simulated, (ii) the BR study uses a correction of COPERT IV, which differs from COPERT V emission factors, and (iii) HERMESv3 uses hourly speed profiles, while BR uses an average daily speed. Following that, the superblocks scenario was simulated for the 9 AM rush hour (figure 1b). The blue links represent a reduction on emissions while red ones indicate an increase. Although total NOx emissions at the marked superblock area are very similar between both scenarios, strong emission gradients appear between neighbouring streets. For example, Street 1 (marked on figure 1b) suffered a reduction of traffic flow of 92% which lead a reduction in NOx emissions

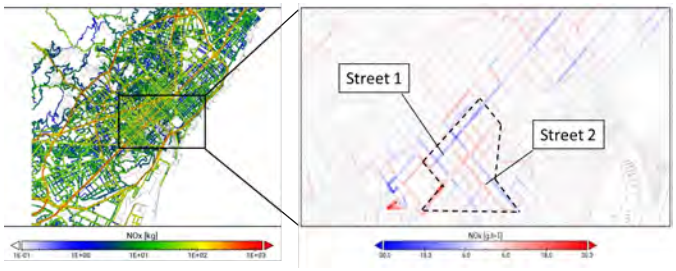


Fig. 1. a) Aggregated NOx emissions for the BAS scenario at 30 meters resolution; b) Difference in NOx emission between the BAS and the TR scenarios at 30 meters resolution, both at 9 AM local time. The dotted line represents the superblock area.

of 93%. On the other hand, street 2, which crosses street 1, had an increase in NOx emissions of 95% as a consequence of traffic increase of 80%. Additionally, the dynamic system allows to observe emission variances in other areas of the city as a consequence of the simulated superblocks. On further steps of this work other TMS will be simulated together with air quality results.

## II. Acknowledgment

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**Daniel Rodriguez-Rey** Holds a MSc in Air Pollution Management and Control by the University of Birmingham, and a BSc degree in Chemical Engineering by the UPC. Currently he is doing a Ph.D in Environmental Engineering with Marc Guevara (BSC-ES), Josep Casanovas (BSC-UPC) and Mª Paz Linares (inLab) in the evaluation of the impact of mobility policies in Barcelona's air quality by the development of an integrated model.